GUIDELINES FOR 4-LANE TO 3-LANE CONVERSIONS

EXECUTIVE SUMMARY

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INTRODUCTION

Many urban areas in Michigan and throughout the United States are implementing traffic calming measures in an attempt to reduce the speed of vehicles on residential and arterial streets. One of the measures being used for this purpose is the conversion of a four-lane undivided cross section to a three-lane cross section (often with bicycle lanes provided on both sides of the road). Unfortunately there are no published guidelines to assist in determining when this traffic calming measure should be used.

Some of the applications in Michigan have been on local streets, and thus did not require Michigan Department of Transportation (MDOT) approval. However, many of the applications have been on Urban Trunkline Roads (M-43 in East Lansing, M-83 in Frankenmuth, etc.). The objective of this study was to develop guidelines for MDOT to use in reviewing requests from local communities to convert four lane urban trunklines to the three-lane configuration.

This study was designed to analyze the operational and safety impacts of a reduction of four lane streets to three lane operations with one lane in each direction and a center turn lane. These projects are sometimes referred to as "Road Diet" projects. On a four lane street, drivers change lanes to pass slower vehicles, whereas on a two lane street, speeds are limited by the speed of the lead vehicle. Thus, the reduction in laneage is intended to reduce speeds, and consequently to reduce the total number and severity of crashes. The added advantages include convenience to pedestrians, as they have to cross only two through lanes of traffic as compared to four, and will face reduced traffic

speeds. Moreover, bicyclists experience an increased comfort level and safety by being separated from motorized traffic when bicycle lanes are provided.

The literature contained a description of case studies from eight different states where road diets were deployed. Table 1 summarizes the results of the literature review related to traffic crashes. Each of the sites reported in the literature experienced a reduction in traffic crashes. The reduction ranging from 5 percent to over 60 percent, with a 25-30 percent reduction being the most common finding.

Table 1 – Reported Crash Experience with 4 lane to 3 lane Conversions

Location		Annual Crashes		Percent Change
State	City	Before	After	
California	Oakland	80	55	-31
California	San Leandro	33	24	-27
Minnesota				-33 (Injury)
Montana	Billings			-62
California	Oakland	46	27	-41
California	Oakland	27	19	-30
California	San Francisco	72	59	-18
California	Sanheadro	47	40	-19
Washington	Seattle	21	19	-10
Washington	Seattle	19	18	-5

Surprisingly, even though many of these projects were initiated as a traffic calming measure, very few measured the change in travel time or the speed of traffic.

In a study by Hummer and Lewis at North Carolina State University the operational characteristics of the four lane and three lane configurations were estimated based on a simulation model. The results generally show that for ADT over 15,000 a four lane cross-section will operate at a higher LOS than a three lane cross-section for all categories except for residential development. For residential areas the level of service (LOS) was equal.

MICHIGAN EXPERIENCE

A total of nine sites were used in the analysis of the Michigan experience of converting a four lane cross-section to a three lane cross-section. Table 2 lists these sites, along with a brief description and the date of the conversion. Six of the nine sites were on urban trunklines, and the other three were on local streets. The conversions occurred between 1989 and 1999, but only one site was converted prior to 1996.

The number of reported crashes on each of the study sections was extracted from the Michigan Department of Transportation Crash files for the year 1988 through 1999. These data are also shown in Table 2, and were used to determine the average reduction in crashes following the conversion.

There were only two sites that had at least three years of data in both the "before" and "after" period, and each of these sites experienced a 27.6% reduction in crash frequency. This is consistent with the results reported in the literature.

Changes in the crash types were only analyzed for the two sites with three years of data (US-31 in the Village of Parkdale, and Burcham Road in East Lansing), and one site with 2 years of data (M-43 in the City of East Lansing).

There were two crash types that were reduced at all three sites. Pedestrian and bicycle related crashes decreased from 12 to 2 on M-43; from 8 to 3 on Burcham Road; and from 1 to 0 on US-31. Intersection crashes decreased from 175 to 82 on M-43; from 43 to 28 on Burcham Road and from 20 to 19 on US-31.

The results for rear-end crashes was mixed with two sites experiencing a reduction, and one site experiencing an increase. At the M-43 site, this type of crash was

TABLE 1 **Traffic Crashes on the Michigan Sites by Year**

Trunk Line/Street Name	Location	Date of Converstion	Total Number of Crashes											
			1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
M-83	City of Frankenmuth	Sep-99	35	36	34	23	27	24	20	24	19	14	16	18
US-31	Village of Parkdale	Oct-96	14	19	10	17	20	20	10	11	11	11	11	12
M-115/M-55	City of Wexford	89	8	14	11	7	4	12	13	19	12	10	12	13
M-43	City of East Lansing	Oct-97	130	123	100	101	87	94	82	101	84	74	40	62
M-53/M-142	City of Bad Axe	Aug-98	29	49	56	37	27	56	41	53	36	45	48	28
M-81	City of Caro	Sep-98	58	48	52	49	27	31	37	39	34	50	21	9
Kalamazoo St-Pennsylvania Ave to US-127	City of Lansing	Fall-98	67	61	63	54	53	47	55	64	51	65	51	35
Abbott Road	City of East Lansing	Jul-99	54	69	53	37	28		33	49	48	45	42	39
Burcham Road	City of East Lansing	Jun-96	13	16	16	19	11	19	11	16	13	10	10	13

reduced from 85 to 59; on Burcham Road the reduction was from 7 to 2; but on US-31 this type of crash increased from 10 to 17.

Driveway related crashes also showed mixed results. However the numbers are small and the difference may not have practical significance. For this crash type, M-43 experienced an increase from 6 to 7, while Burcham Road (5 to 1) and US-31 (5 to 2) experienced a decrease in driveway related crashes.

Mid-block crashes also showed mixed results, but in this case two of the three sites experienced an increase in the crash frequency. On M-43, the number of crashes doubled from 10 to 20; on Burcham Road the increase was from 3 to 5; but on US-31 this crash type decreased from 21 to 15.

DELAY ANALYSIS

The Abbott Road site located in the City of East Lansing was selected as the test site for the operational analysis. Abbott Road was converted from four lanes to three lanes in the summer of 1999. The project runs for 0.4 miles, from Burcham Road to Saginaw Street. There are traffic signals at each of these two end points, with stop controlled intersections between the ends. The street is basically a commercial street, but with business type commerce rather than consumer based commerce. There are a total of five stop-controlled intersections and seven driveways within the test section.

A series of sensitivity analyses were conducted to provide guidance for establishing the desired guidelines. The variables included in the sensitivity analyses were the minor street access density (access points per mile) and the percentage of vehicles turning left from the major street for different major street volumes.

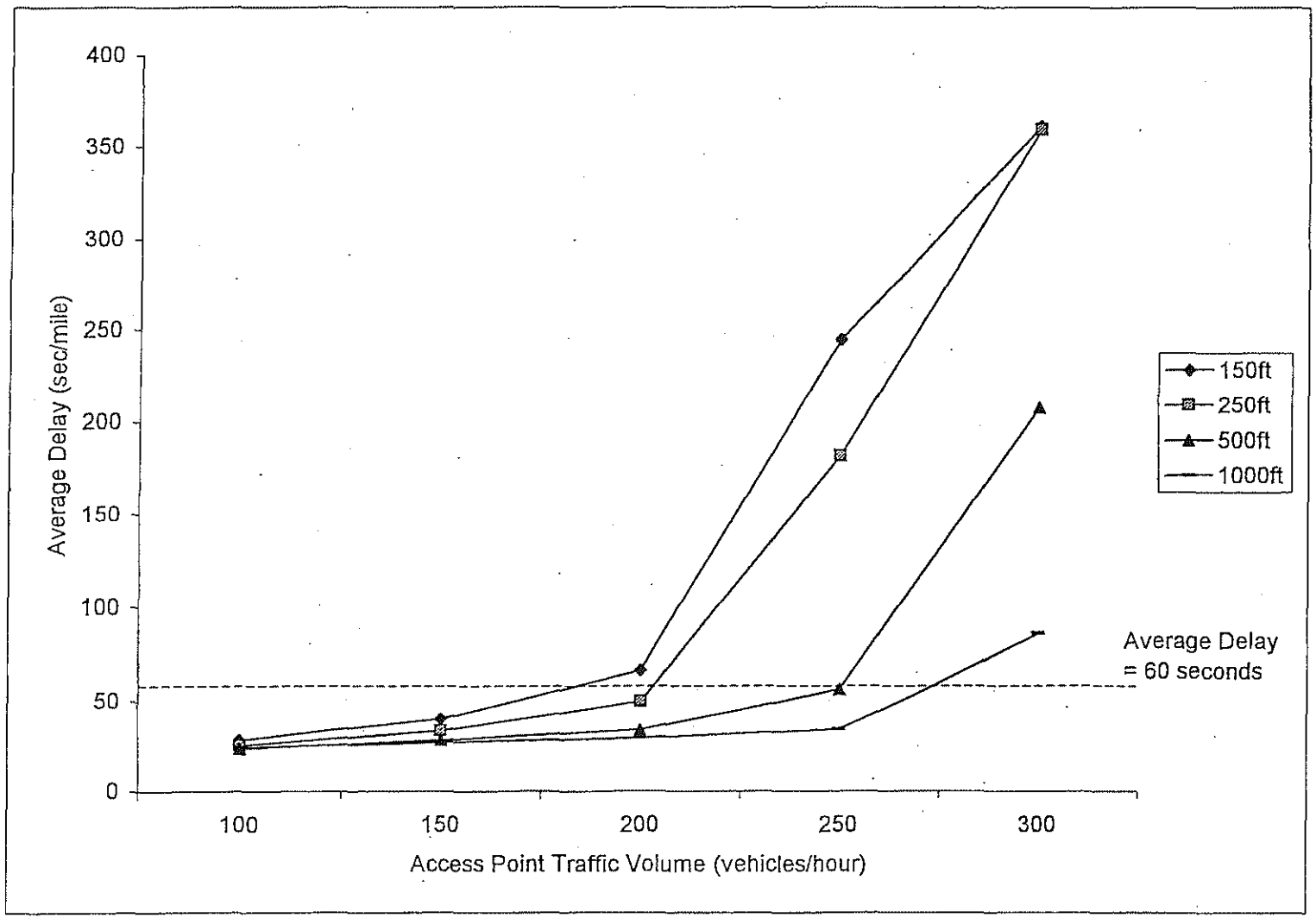
The first analysis was conducted to determine the impact of the minor street volume on the average delay to traffic on the major street. The major street volume for these simulation runs was 1000 to 2000 vehicles per. The results show that the minor street volume does not effect delay on the major street, at least in the volume range of interest to this study. There is very little effect on the average delay for volumes as high as 2000 vph when the left turn percentage is five percent. With ten percent left turns, the average delay increases from about 5 seconds at a volume of 1000 vph to 12 seconds at a volume of 2000 vph.

If the turning percentage reaches twenty percent, the delay increases very rapidly, and the site would become congested, with an average speed of only 22-mph. This would be an unacceptable level of service, even for a residential street. However, it is not likely that any site with a volume of 2000 vph in the peak hour would also have twenty percent of the traffic turning left at each access point.

A set of nomographs were developed to provide guidance in determining whether a four lane to three lane conversion would result in an undesirable level of delay to the main street traffic. The variables included in the graph are the major street volume, the volume on the minor street (or driveway), the access point average spacing and the percent of vehicles turning left from the major street.

Figure 1 is presented to illustrate the relationship among these variables. For a candidate site carrying a volume of 1000 vph (in both directions combined), with 5% of the vehicles turning left from the main street at each access point; IF an average delay of one minute (60 seconds) per mile is selected as an acceptable criterion, THEN a site with an average spacing between access points of 1000 feet with volumes as high as 275 vph

Figure 1 Average Delay per Vehicle for - Major Street Volume of 1000 veh/hour with 5% Left Turns



approaching the major street, the conversion would still be acceptable. With the same assumptions, if the average spacing between access points is only 250 feet, the maximum volume at the access points would be 200 vph before the delay exceeded this criterion.

All residential streets with an ADT of less than 10,000 (and thus a peak hour volume of less than 1000 vph) would be acceptable candidates for the conversion under this definition of acceptable delay.

Similar figures for major street volumes of 1200, 1400, 1600, 1800 and 2000 vph are included in the report. Figures for volumes from 1000 vph to 2000 vph with 10% of the traffic turning left are also included in the report.

CONCLUSIONS

The safety impact of converting four lane roads to three lane roads with a continuous two-way left-turn lane appears to be positive at all volume levels where the conversion has been used. The average reduction in crashes reported in the literature was 25 to 30 percent. The experience in Michigan has been similar, with the two sites with at least three years of crash data available averaging a 27.6 percent reduction.

At the Michigan sites, pedestrians and bicycle crashes showed the most consistent results and experienced the highest reduction, decreasing from 21 to 5 at the three sites where data exists. Intersection crashes also decreased at each of these sites, with the total number of crashes being reduced from 238 to 129.

An analysis of the average delay to vehicles on both the major street and the minor streets (or driveways) was conducted. The minor street delay increases as the major street volume increases because the delay is created by vehicles waiting for an acceptable gap in the traffic stream. There is no significant queuing delay until the minor

street approach volume reaches 180 vehicles per hour. At this volume, the traffic signal

The delay to traffic entering the major street would not be significant for volumes associated with residential streets, where the conversion is frequently used as a traffic calming measure. The delay to the major street traffic is also low for the volume levels of most residential streets.

The delay to both the minor street (or driveway) and the major street traffic increases rapidly as the volumes reach levels associated with commercial streets. As the major street volume approaches 2000 vehicles per hour, and the minor street volume approaches 200 vehicles per hour, the delay to both traffic stream becomes large. Nomographs illustrating the increase in delay to the major street traffic are contained in this report.

Proposals to convert 4 lane streets to 3 lane streets should be based on an engineering study that considers the potential crash reduction and the estimated delay from the nomographs included in this report. If traffic signals are located in the corridor, an intersection capacity analysis should be performed at each signalized intersection.